IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

PHILLIPS et al. Atty. Ref.: SCS-124-1158

Serial No. 10/577,938 TC/A.U.:

Filed: May 3, 2006 Examiner:

For: STRAINED SEMICONDUCTOR DEVICES

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September 13, 2007

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

RULE 131 DECLARATION SWEARING BEHIND PHILLIPS, U.S. PUBLICATION 2005/0194613 (37 CFR 1.131)

Philip Davies, declares as follows:

1. That, I, Philip Davies, am an European attorney and am knowledgeable of facts relating to the above-identified United States patent application;

2. That, on September 13, 2002, I reviewed and signed an "Invention Submission Receipt Form" attached to an "Invention Record" authored by the co-inventors of the above identified patent application (copies of which are attached hereto);

3. That, I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under

Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: 13 September 2007

Philip Davies

Enclosures:
Invention Submission Receipt Form
Invention Record

INVENTION SUBMISSION RECEIPT FORM

INV No:...1027..... Date of Receipt.....4.9.02.....

Section 1: Declaration

QinetiQ Intellectual Property has given a commitment to our customers that the following declaration will be signed within 10 working days of receipt of all relevant information.

I have read and understood the Invention Submission

Attorney Name:...Phil Davies.....

Signature:...R Davies.....

Date Read:.....13.9.02.....

Section 2: Decision on Patent Action made in conjunction with Divisional IP Managers

Comments on scope of patentability and commercial application:

Idea seems patentable. BG want this as invention used per deal with Intel

☐ Record IP

☑ File ☐ 01P..... ☑ EXP....7207.....

Attorney Name:...Phil Davies.....

Signature:...R Davies.....

Date:.....13...Sep 2002.....

WHEN COMPLETED PASS TO BUSINESS SUPPORT FOR DATABASE UPDATE AND FILING

Invention Record

Strained Transport Devices in Narrow Bandgap Semiconductors

21st August 2002

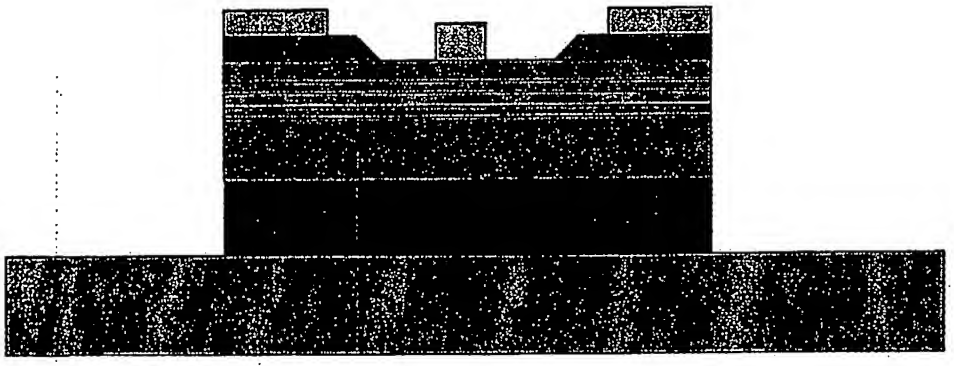
Tim J. Phillips

Tim Ashley

This invention report covers the use of strained regions in narrow bandgap semiconductor devices to exploit the large strain band-splitting effect which allows very high mobility light holes to be dominant in transport, allowing high performance p-type transistor devices.

1. FET devices

In the case of a QW FET device, like those disclosed in previous QinetiQ patents (T. J. Phillips, 2000, 'Quantum Well Field Effect Transistors with Carrier Extraction', *UK Patent Application No. 0012017.0.**, T. J. Phillips, 2002, 'Method for Suppression of Impact Ionisation', *UK Patent Application No. 0206572.0.**), there exists the opportunity to build a significant amount of strain into the device as the lattice constant of AlSb, for example, is considerably smaller than that of InSb. This therefore allows an InSb quantum well to be strongly compressively strained. The strain effect in the InSb is very strong, as shown by theory (*we have a theoretical graph we can use here*), and in principle allows the energies of the light and heavy holes to be split by an amount much greater than kT. As the mobility of the light holes is almost as large as that of electrons in InSb, this opens up the possibility of very high performance hole-based devices as well as electron-based ones. This then makes very high speed, low power complementary logic circuits to be designed, with resulting advantages in circuit performance and quiescent power consumption.



In the diagram above the pink region would be an InSb quantum well, modulation- or directly doped with p-type dopants. The purple regions surrounding it would be $In_{1-x}Al_xSb$, with x high enough to induce sufficient strain. The blue regions are p-type contacts to the p-channel, with the central electrode being a Schottky gate in this embodiment (although oxide-based gates can also be used). The grey region is an insulating substrate (possibly GaAs) and the dark purple region an optional highly n-type doped back contact for carrier extraction purposes.

2. Bipolar devices

In the case of a bipolar device like those disclosed previously (T. J. Phillips, 2000, 'Narrow Bandgap Bipolar Transistors', *UK Patent Application No. 0012925.4.**) made from a narrow bandgap material, it should also be possible to strain the base (which needs to have good hole transport in a n-p-n device) to allow light hole transport for the same reason as above. In this case, in the diagram, the blue regions surrounding the pink base region under the emitter, and the additional pink base contact region below the base contact, are all wider bandgap (and smaller lattice constant) $In_{1-x}Al_xSb$, with an appropriate x value. This allows almost all of the base region to be strained, and therefore show light hole transport. This should allow faster device speed, and lower base access resistance improving power gain.

Extra Notes on Patenting

1. It is worth noting that while the effect is strongest in InSb, it also applies to other narrow bandgap materials, such as InAs.